(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 297 278**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88108321.6**

(51) Int. Cl.4: **H02K 3/487**

(22) Date of filing: **25.05.88**

(30) Priority: **03.06.87 JP 138080/87**

(43) Date of publication of application:
04.01.89 Bulletin 89/01

(84) Designated Contracting States:
DE GB

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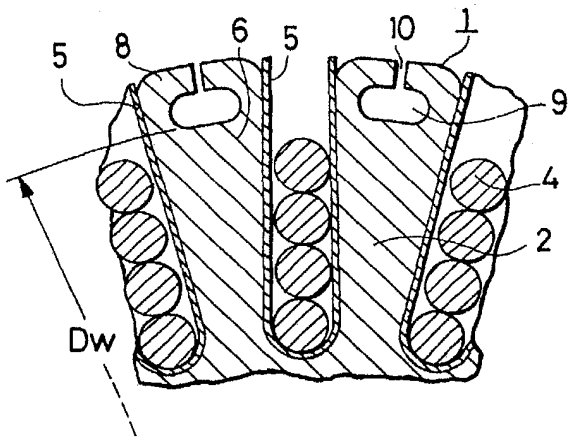
(54) Armature of rotary machine and manufacturing method thereof.

(57) An armature (1) is formed by laminating cores having through window portions (9) which are provided in the vicinity of the surface on the slot open sides of tooth portions. The through window portions have partly opened portions (10), respectively. Coils (4) are wound in slots of the laminated core. By pressing the through window portions, cut-open portions (10) of the slot are deformed to prevent the slipping-out of the coils.

FIG. 2



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ARMATURE OF ROTARY MACHINE AND MANUFACTURING METHOD THEREOF

FIELD OF THE INVENTION

The present invention relates to a manufacturing method of an armature of a rotary machine, and particularly to an armature of a rotary electric machine being suitable for forming a half-closed slot which is effective for the prevention of slipping-out of windings.

BACKGROUND OF THE INVENTION

The half-closed slot for preventing the slipping-off of windings in the armature of the rotary machine is usually formed by providing beforehand a projecting portion in the vicinity of a slot portion on the slot open side of the armature and by bending the projecting portion inside the slot by pressing or the like. as is disclosed, for instance, in U.S. Patent No. 3.586.893 patented on June 22, 1971 in the title of "Armature Core" and Japanese Patent Laid-Open No. 52-9805 (1977) published on January 25, 1977 in the title of "Manufacturing Method of Armature of Small-scale rotary machine".

However. the above-stated prior art causes such disadvantages as will be described below.

On the occasion when the projecting portion is bent inside the slot by pressing or the like, the fore end portion of this bent projecting portion falls down to cause a damage to an insulating coat on the surface of a winding held in the slot, thus tending to cause dielectric breakdown. Moreover, as in the armature of Japanese Patent Laid-Open No. 52-9805 (1977) of the above-mentioned prior part. when the projecting portion is grooved on the lateral side thereof and bent inside the slot the mechanical strength of the aforesaid projecting portion is deteriorated by a groove provided on the lateral side of the projecting portion for bending, and consequently said portion is sometimes cut off in the course of highspeed rotation. Furthermore, when the half-closed slot is formed by pressing a semicircular projection in the armature core of U.S. Patent No. 3 586 893 mentioned above, a large load pressure is needed, which requires employment of a large-sized apparatus, and also this art involves a drawback that irregularity is easily formed on the outer peripheral surface of the armature when the half-closed slots are formed by pressuring the semicircular projections, so that the uniformity of magnetic reluctance of the armature tends to be deteriorated.

SUMMARY OF THE INVENTION

An object of the present invention is to furnish an armature of a rotary electric machine and a manufacturing method thereof wherein a projecting portion for preventing the slipping-out of windings is formed in the open portion of a slot so that the inside of the slot can be formed in a curved shape without fail.

The object of the present invention is attained by a method wherein a through window portion whose outer periphery is cut to be opened partly is provided in the vicinity of a slot open side of a core tooth portion between slots of an armature core, lamination is made, an armature coil is provided by winding, a projecting portion (anchor) is formed on the opposite lateral sides of a slot open end thereafter by pressing the surface of the armature core, and thereby the half-closed slot is formed.

A partly-open through window portion provided in the vicinity of the outer peripheral surface of a tooth portion of the armature core has a cut-opened portion in the outer periphery. In the case when this portion is deformed by pressing, a core portion forming a projecting portion (anchor) for preventing the slipping-out of windings is prevented from falling down inside a slot by a tension produced by the annular portion of the deformed portion, and thus an ideal curved projecting portion can be attained, while the projecting portion can be formed in large extension inside the slot due to the presence of the aforesaid cut-opened portion. In the open end of the slot, in this way, the projecting portion for preventing the slipping-out of windings which has an ideal shape of the inner periphery being curved and also a relatively large projection can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a partial section of an armature of a rotary machine according to the present invention;

Figure 2 shows a state wherein the armature core is constructed by laminating steel plates having a predetermined shape;

Figure 3 shows a state wherein, after the armature coils are inserted into the slot as shown in Figure 2, pressing is made by a pressing tool from the direction indicated by an arrow P;

Figure 4 shows an armature wherein the fore end of the tooth portion of the laminated core, i.e. the through hole of the window portion thereof, is

crushed by the pressing process and, consequently, the upper end portion is put in a state of close contact with the upper end of the tooth portion;

Figure 5 shows a section of another example of a pressing tool of Figure 3; and

Figures 6A, 6B, and 6C show other examples of window portions of a core shown in Figure 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a section of a part of an armature 1 of a motor of an automobile starter, for instance, which is manufactured according to the present invention. In the figure, a plurality of steel plates machined to have a prescribed shape are laminated on a rotating shaft (not shown in the figure) to construct an armature core 2. A plurality of slots 3 extending in the direction of the shaft are provided in the circumferential surface of this substantially cylindrical armature core 2, and a plurality (four in the present embodiment) of armature coils 4 each having a surface coated for insulation are provided by winding in each slot 3. Moreover, insulating paper 5 is provided on the inner peripheral surface of the slot 3 to protect the insulation between the armature coils 4 and the core 2. Besides, an insulated mold 13, such as varnish, for fixing the coils 4 is packed in the slot 3 in the figure.

As is apparent from the figure, projecting portions (anchors) 7a and 7b expanded on the opposite sides so that the inside of the slot be curved are formed in the opposite end portions of the fore end of an armature core 2. Thereby the slot 3 is put in a half-closed state, whereby the slipping-out of the coils is prevented when an armature is rotated.

Next, a method of forming a half-closed slot by the projecting portions 7a and 7b of Figure 1 will be described in detail with reference to Figures 2 to 4.

Referring to Figure 2, an annular portion 8 of a laminated core forming a window portion at least a part of which is opened outside is formed in the fore end portion of a tooth portion 6 of the steel plates constituting an armature core 2, in other words, in the vicinity of the outer peripheral surface thereof. In other words, a cut-opened portion 10, together with a through hole 9, is formed in the fore end portion of the tooth portion 6 of the core on the occasion when the steel plates are punched to be in a prescribed shape, for instance. In this state, projecting portions shown in 7a and 7b of Figure 1 are not yet formed in the fore end portion of a slot 3, and armature coils 4 are inserted through the open end portion thereof after insulating paper 5 is provided inside of it. In the figure, mark Dw denotes a distance from the center of the rotating shaft of an armature 1 to the aforesaid window portion.

Referring to Figure 3, the opposite end portions 9 of the annular portion 8 of a laminated core are deformed while projecting onto the slot 3 side when a partly-open window portion formed in the fore end of the core tooth portion 6 is crushed to be deformed by a pressing load P. On the occasion of pressing, however, the upper end face of the aforesaid annular portion 8 is in contact with the pressing tool 11, and therefore it does not occur that this portion is bent onto the slot 3 side with the fore end falling down inside the slot. Instead, the inside of the slot is turned into a curved shape by this pressing, and thus the projecting portions 7a and 7b shaped ideally so as not to damage the surface insulating coat 5 of the armature coil 4 held inside can be formed as projections for preventing the slipping-out of the coil 4. Besides, the upper end of the annular portion 8 of the core is separated to the right and left by the opened portion 10 on the occasion of this pressing, and this opened portion 10 is expanded with the formation of the projecting portions 7a and 7b by the pressing. Therefore said projecting portions 7a and 7b project easily inside the slot 3, and thus the projecting portions 7a and 7b larger than those formed when the opened portion 10 is not provided in the upper end of the annular portion can be obtained. Furthermore, in order to make the projecting portions 7a and 7b project to a larger extent, a pressing tool 11' for opening an aperture of the aforesaid opened portion 10 to be wider, e.g. a tool having such a section as shown in Figure 5, can be employed instead of the pressing tool 11 of Figure 3.

After the fore end of the tooth portion 6 of the laminated core 2, i.e. the through hole 9 of the window portion thereof, is crushed by the above-stated pressing process as shown in Figure 4, and consequently, the upper end portion is put in a state of close contact with the upper end of the tooth portion 6; varnish, for instance, is packed in the slot 3 to fix the coils therein, and the outer periphery of the armature 1 is machined to be cut, so as to remove the unnecessary portion of the window portion crushed by the pressing process, i.e. the upper end portion of the annular portion 8 of the core. By this cutting, the surface of the armature 1 is made smooth as shown also in Figure 1.

In the Figure 4, mark Dw denotes a distance from the center of the rotating shaft to the window portion, and further mark Do denotes a distance between the center of the rotating shaft and the cut

portion of the armature 1 formed by the aforesaid cutting. This distance Do is equal to or smaller than Dw at least, and it is selected, of course, to be within a range wherein the projecting portions 7a and 7b formed in the fore end of the aforesaid tooth portion 6 of the core are left sufficient.

In the above-described embodiment, i.e. in the armature 1 of a starter motor, the aforesaid cutting process is conducted to make uniform the magnetic reluctance of the surface of the armature. It is also possible to use the armature in the state of Figure 4 as it is. In this case, however, the surface magnetic reluctance becomes not uniform due to the presence of the annular portion 8 of the core and the opened portion 10 thereof pressed to contact closely with the fore end of the tooth portion 6 of the core, and magnetism passing through the core is divided to the right and left to the center of the aforesaid opened portion 10. In the above-described embodiment, besides, varnish or the like is packed in the slot 3 after the completion of the pressing process. It will be apparent, in this relation, that this packing is not necessarily needed for a motor of which the number of revolutions is not very large, or the like.

Next, Figures 6A, 6B and 6C show other examples of deformation with respect to the shape of the window portion formed in the fore end of the tooth portion 6 of the armature core 1. In the case of the shape of the window portion shown in Figure 2, the annular portion 8 of the core is expanded onto the opposite sides of the tooth portion by pressing, so as to form the projecting portions 7a and 7b. In an embodiment of Figure 6A, the window portion formed in the fore end of the tooth portion 6 of the core is provided, in the substantially central part of the through hole 8 thereof, with a protuberant portion 12 opposite to the opened portion 10. When the window portion shaped as above-stated is pressed, the annular portion 8 of the core in the fore end of the tooth portion 6 of the core is expanded on both sides easier than that of Figure 2, and thereby the projecting portions being larger in the shape can be obtained compared with 7a and 7b of Figure 4.

In an example of deformation shown in Figure 6B, a protuberant portion 12' is made larger than the one of Figure 6A with a view to obtaining also the projecting portions 7a and 7b enlarged further on the lateral sides by the plastic deformation of the window portion of the core at the time of pressing. Moreover, an example of deformation of Figure 6" C, although similar in the shape to the one of Figure 6A, is aimed to enable smoother plastic deformation of the core by pressing by constructing the window portion of the core and, especially, a protuberant portion 12", to be curved.

As described above, the manufacturing method of an armature according to the present invention enables the sure manufacture, by a relatively simple apparatus, of the armature of a rotary machine having projecting portions (anchors) which have an ideal shape of a curved inner peripheral surface causing no damage to the surface coat of windings provided inside a slot and which can be expanded to a relatively large extent.

Claims

1. An armature (1) of a rotary machine comprising a laminated cores (2) which are formed a plurality of slots (3), windings (4) which are wound in the slots of the laminated core, and projecting portions (7a, 7b) which are formed by deforming partly opened portions (10) of the slots of the laminated core so as to prevent a slipping-out of the windings,
characterized in that each of said projecting portions is formed to have a curved inner peripheral surface by pressing a through window portion (9) which is provided in the vicinity of the surface on the slot open side of a tooth portion between said slots of said laminated core and has a cut-opened portion in the outer peripheral annular portion thereof.

2. An armature of a rotary machine according to claim 1, wherein said projecting portion is formed in projection at opposite ends of said open side of said slot.

3. A manufacturing method of an armature (1) of a rotary machine comprising a step of forming a laminated core by laminating steel plates having a plurality of slot portions (3) formed therein, a step of winding coils (4) which are wound in the slot portions of the laminated core, and a step of forming half-closed slots by pressing open sides of the slots of the laminated core wherein the coils are wound,
characterized in that
further comprising a step of forming a through window portion (9) having a cut-opened portion (10) in an outer peripheral annular portion in a vicinity of a slot open side of a tooth portion between a plurality of slots of said laminated core prior to the step of pressing said open side of said slot portion, and a step of forming said half-closed slot by the step of said pressing thereafter.

4. A manufacturing method of an armature of a rotary machine according to claim 3, wherein a direction of a pressing load in the step of pressing executed after the step of forming said through window portions in said laminated core of said armature is vertical to said open sides of said slot of said laminated core.

5. A manufacturing method of an armature of a rotary machine according to claim 3, wherein a step of giving a curved shape to a fore end portion of a tooth portion of said core after a formation of said slot is contained further in the step of forming said through window portion in said laminated core of said armature.

FIG. 1

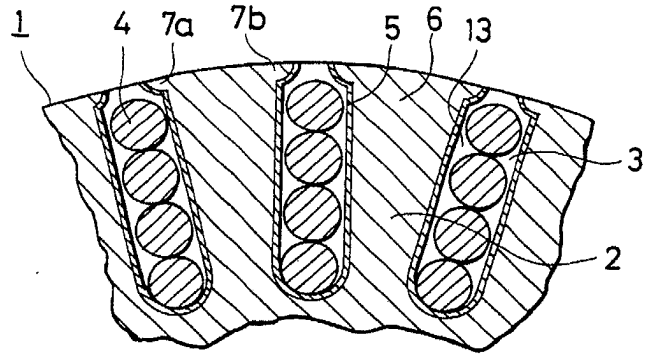

FIG. 2

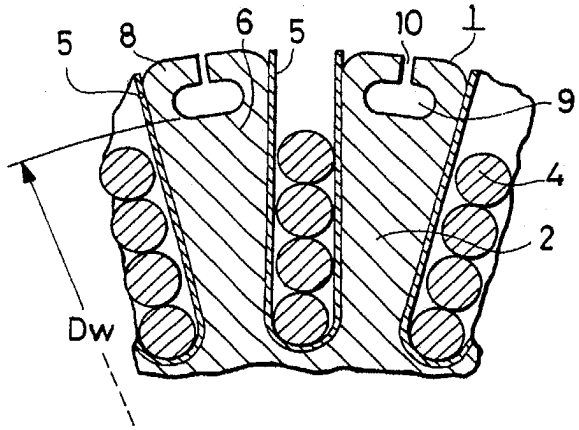

FIG. 3

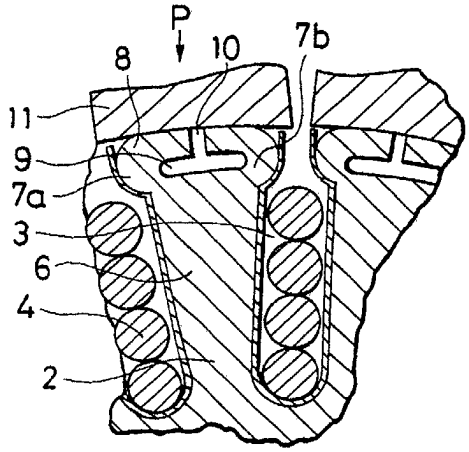

FIG. 4

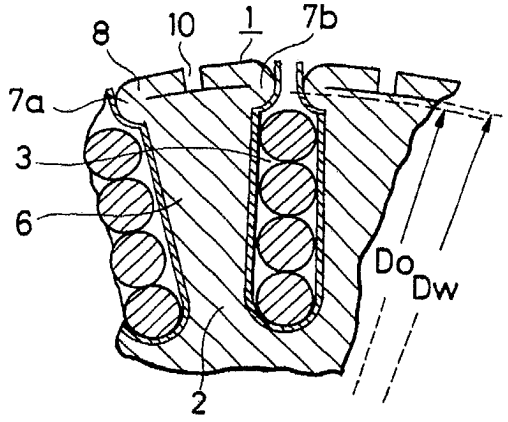

FIG. 5

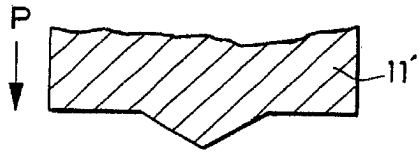

FIG. 6A

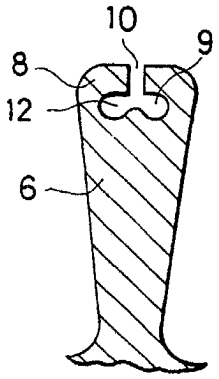

FIG. 6B

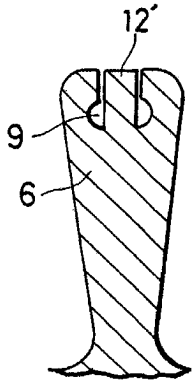

FIG. 6C